

Management Measure 3

Watershed Protection

A. Management Measure

Develop a watershed protection program to:

- Avoid development of areas that are particularly susceptible to erosion and sediment loss.
 - Preserve areas that provide important water quality benefits and/or are necessary to maintain riparian vegetation and aquatic biota.
 - Site development projects, including roads, highways, and bridges, to protect the natural integrity of waterbodies and natural drainage systems.
-

B. Management Measure Description and Selection

1. Description

The purpose of this management measure is to reduce the generation of nonpoint source pollutants and to mitigate the impacts of urban runoff and associated pollutants from new development and redevelopment, including the construction of new and relocated roads, highways, and bridges. It is intended to provide general goals for local agencies and urban communities in developing comprehensive programs for guiding future development and land use activities in a manner that will prevent and mitigate the effects of nonpoint source pollution.

Although the goals of this management measure and Management Measure 4 (site development) are similar, this measure is intended to apply to larger watersheds or regional drainage basins rather than individual sites. The watershed protection and site development management measures are intended to be complementary. They can be used together with the other management measures in a comprehensive framework to control runoff and reduce nonpoint source pollution. (See Chapter 1 for a description of the runoff management program framework.)

Comprehensive planning is an effective nonstructural tool to control nonpoint source pollution. Where possible, growth should be directed toward areas where it can be sustained with minimal impact on the natural environment (Meeks, 1990). Poorly planned growth and development have the potential to degrade and destroy natural drainage systems and surface waters (Mantel et al., 1990). By making proper planning and zoning decisions, water quality managers can direct development and land disturbance away from areas that drain to sensitive waters. Land use

designations and zoning laws can also be used to protect environmentally sensitive areas such as riparian corridors and wetlands.

Riparian buffers and wetlands can have the benefit of providing long-term pollutant removal capabilities without the comparatively high costs usually associated with constructing and maintaining structural controls. Conservation or preservation of these areas is important to water quality protection. Land acquisition programs help to preserve areas considered critical to maintaining surface water quality. Adequate buffer strips along streambanks provide protection for stream ecosystems, help stabilize the stream, and can prevent streambank erosion (Holler, 1989). Buffer strips can also protect and maintain near-stream vegetation that attenuates the release of sediment into stream channels. Levels of suspended solids have been shown to increase at a slower rate in stream channel sections with well-developed riparian vegetation (Holler, 1989).

2. Management Measure Selection

This measure was selected for several reasons. First, watershed protection is a technique that provides long-term water quality benefits, and many states and local communities have adopted this practice. Numerous state and local governments have already legislated and implemented detailed watershed planning programs that are consistent with this management measure. For example, Oregon, New Jersey, Delaware, and Florida have passed legislation that requires county and municipal governments to adopt comprehensive plans, including requirements to direct future development away from sensitive areas. Many municipalities and regions have adopted land use and growth controls, including the towns of Amherst and Norwood and the Cape Cod region of Massachusetts; Narragansett, Rhode Island; King County, Washington; and many others.

Second, there is general recognition that the protection of sensitive areas and areas that provide water quality benefits is integral to maintaining or minimizing the impacts of development on receiving waters and associated habitat. Without a comprehensive planning approach that includes the use of riparian buffers, open space, bioretention, and structural controls to maintain the predevelopment hydrologic characteristics of the site, significant water quality and habitat impacts are likely. The experience of communities across the country has shown that the use of structural controls in the absence of adequate local land use planning and zoning often does not adequately protect water quality and might even cause detrimental effects such as increased temperature.

Third, this measure is effective in producing long-term water quality benefits and lacks the high operation and maintenance costs associated with structural controls. The Michigan Department of Environmental Quality (no date) compared the costs of two nonpoint source projects. One involved preserving an urbanizing watershed, and the other entailed restoring an urban watershed. Table 4.1 is a side-by-side cost comparison demonstrating that it is generally less costly to protect high-quality streams than to restore them.

Table 4.1: Cost comparison of stream preservation vs. stream restoration (Michigan Department of Environmental Quality, no date).

	Bear Creek	York Creek
Type of nonpoint source project	Preservation	Restoration
Setting	Grand Rapids, MI, area stream	Grand Rapids, MI, area stream
Size	20,096 acres	2,110 acres
Level of urbanization	9.5% (1991)	19% (1993)
Stream category	High-quality trout stream	Former trout stream
Storm water ordinance	\$10,000	\$10,000
Decision-making GIS	\$10,000	\$10,000
Information/education program	\$100,000	\$80,000
Streambank stabilization	\$15,000	\$130,000
Storm water basin retrofits	–	\$180,000
Additional storm water basins	–	\$75,000
Other practices (habitat improvement, repairing road crossings, etc.)	\$75,000	\$190,000
Total cost	\$210,000	\$675,000
Total cost per acre	\$10.50/acre	\$319.90/acre

C. Management Practices

The practices included under the watershed protection management measure fall under the following five categories:

- Identifying critical conservation areas.
- Preserving environmentally significant areas.
- Establishing stream buffers.
- Promoting urban forestry.
- Encouraging development for waterbody and natural drainage protection.


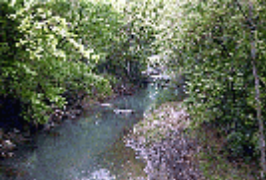



The first category of practices entails identifying properties that if preserved or enhanced could maintain or improve water quality and reduce the impacts of urban runoff. The second group, which involves preserving environmentally significant areas, includes land acquisition, easements, and development restrictions of various types. The third group of practices describes steps important for protecting or establishing riparian buffer zones to enhance water quality and pollutant removal. Next, a discussion of urban forestry practices is presented, followed by descriptions and applications of zoning techniques that can be used to limit development density or redirect density to less environmentally sensitive areas.

1. Identify Critical Conservation Areas

Achieving the first two elements of this management measure, which are (1) to avoid developing areas especially susceptible to erosion and sediment loss and (2) to preserve areas that provide important water quality benefits, usually requires implementation of management practices aimed at preserving and managing lands that mitigate runoff impacts and support critical ecosystem functions. These types of lands are described in Table 4.2.

An initial step for incorporating targeted land conservation into a runoff management program is to identify critical conservation areas on a watershed map and then superimpose this information on a tax map. Owners of potential conservation lands could include a mix of individuals, corporations or other business entities, homeowner associations, government agencies, and land trusts.

Table 4.2: Types of lands that should be preserved for watershed protection (adapted from Caraco et al., 1998).

Conservation Area	Description	Examples
<p>Critical habitat</p> 	Essential spaces for plant and animal communities or populations	Tidal wetlands, freshwater wetlands, large forest clumps, springs, spawning areas in streams, habitat for rare or endangered species, potential restoration areas, native vegetation areas, coves
<p>Aquatic corridor</p> 	Areas where land and water interact	Floodplains, stream channels, springs and seeps, steep slopes, small estuarine coves, littoral areas, stream crossings, shorelines, riparian forest, caves, and sinkholes
<p>Hydrologic reserve</p> 	Undeveloped areas responsible for maintaining the predevelopment hydrologic response of a subwatershed	Forest, meadow, prairie, wetland, cropland, pasture, or managed forest
<p>Water pollution hazard</p>  <p>Source: Stapleton, 1999.</p>	Any land use or activity that is expected to create a relatively high risk of water pollution	Septic systems, landfills, hazardous water generators, aboveground or underground tanks, impervious cover, surface or subsurface discharge of wastewater effluent, land application sites, storm water “hot spots,” pesticide application, industrial discharges, and road salt storage areas
<p>Cultural and historic sites</p>  <p>Source: NPS, 2001.</p>	Areas that provide a sense of place in the landscape and are important habitats for people	Historic or archaeological sites, trails, parkland, scenic views, water access, bridges, and recreational areas

2. Preserve Environmentally Significant Areas

Land conservation includes more than simply preserving land in its current state. It also means that an individual or organization should take responsibility for restoration of areas of the property that might already have been affected by urban runoff. Stewardship activities for land conservation might include

- Resource monitoring.
- General maintenance.
- Control of exotic species.
- Installation of structural runoff management practices.

A government agency or a nonprofit organization, such as a land trust, often has a greater capacity to take on the responsibility of stewardship than do private owners. Consequently, many of the practices discussed below focus on how conservation lands, or at least property rights to those lands, can be transferred to such entities. In many instances, however, private owners successfully accomplish stewardship without any formal or binding relationship with a public or private conservation agency or organization.

Several organizations provide educational materials and training to help landowners learn to manage conservation areas for the benefit of water quality, wildlife, and other purposes. For example, the Land Trust Alliance, an organization that “promotes voluntary land conservation and strengthens the land trust movement by providing the leadership, information, skills, and resources land trusts need to conserve land for the benefit of communities and natural systems,” has compiled a list of links to local land trust organizations. This list can be accessed at www.lta.org/resources/links (Land Trust Alliance, 2001). Other information on land conservation policy, news, success stories, training opportunities, and technical guidance is provided on the Land Trust Alliance’s web site at www.lta.org.

Additionally, The Conservation Fund web site, at www.conservationfund.org, provides information on land acquisition, community initiatives, leadership training, and sustainable conservation solutions emphasizing the integration of economic and environmental goals. Another resource is the Natural Lands Trust. Their web site, at www.natlands.org, provides information and resources pertaining to land preservation and land use planning.

The following land conservation management practices are discussed in this subsection:

- Exclusive management, which involves voluntary landowner stewardship.
- Nonexclusive management, including conservation easements, leases, deed restrictions, covenants, and transfer of development rights (TDRs).
- Sale of privately owned conservation land to a government entity or qualified nonprofit organization.
- Donation of privately owned conservation land to a government entity or qualified nonprofit organization.

Figure 4.1 presents these alternatives in the form of a decision tree that incorporates the four basic questions landowners must ask themselves before deciding how to best conserve land. Each option is briefly discussed below.

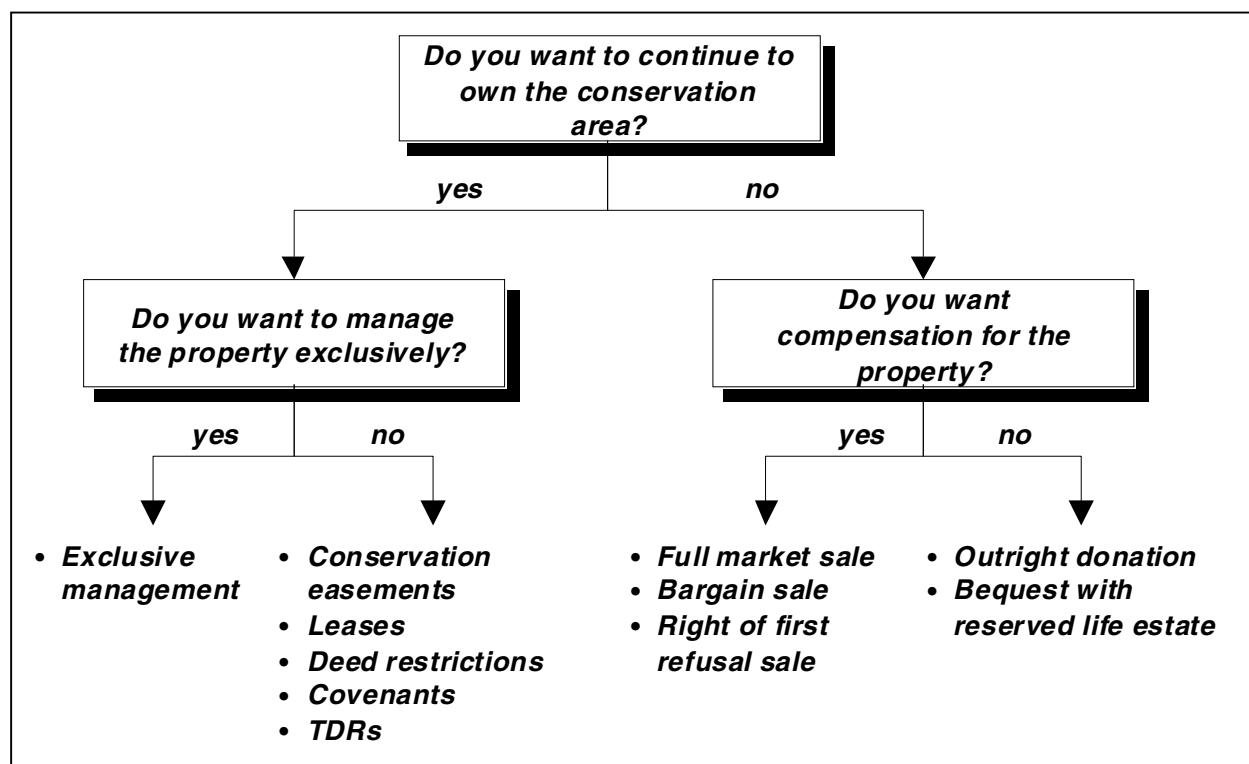


Figure 4.1: Landowner alternatives for conservation area land management (adapted from Cwikiel, 1996).

a. Continue to own the property

- (1) *Exclusive management.* Many of the land conservation practices discussed in this section focus on techniques for transferring the responsibility of protecting and maintaining conservation areas from private landowners to a government agency, land trust, or other entity. In some cases, however, landowners are capable stewards of ecologically important areas. Therefore, voluntary stewardship is a concept that should be encouraged throughout the community through education, outreach, and cost-sharing. Owners of environmentally significant natural areas are often candidates for funded projects that will improve or maintain site conditions. The following are general approaches communities can use to promote stewardship of privately owned conservation lands:

- (a) *Watershed advocacy.* Promoting watershed advocacy through an education and outreach program lays the foundation for public awareness and support, which are critical elements in any runoff management program. One of the most important investments a community can make toward runoff control is to support nongovernmental organizations, which can be forceful advocates for management of natural areas. They also have an

ability to develop broad-based popular support for watershed programs, especially where local governmental resources are limited.

- (b) *Public education.* There is no shortage of public and private organizations eager to dispense information and offer technical assistance in managing conservation lands. National and state program leaders can form partnerships with local conservation districts (for more information on local conservation districts, see the National Association of Conservation Districts web site at www.nacdnet.org) or individuals for the distribution of educational materials and stewardship training. In some cases, this partnership is formalized through a nonregulatory agreement that outlines the responsibilities of each partner. In addition to developing education materials, communities can help broker partnerships and become partners themselves.
- (c) *Volunteer monitoring.* Land stewards should be aware of environmental conditions in conservation areas over time. Communities can foster this awareness by establishing a local volunteer monitoring program or encouraging residents to participate in an established regional or state-level volunteer monitoring program. EPA's Volunteer Monitor provides more information about volunteer wetland monitoring at www.epa.gov/volunteer/spring98/index.html (USEPA, 1998).

Case Study: Michigan Natural Areas Registry

The Michigan chapter of The Nature Conservancy promotes land conservation stewardship education through the Michigan Natural Areas Registry. Candidate lands for the Registry are selected from the Michigan Natural Features Inventory, a state program that identifies significant natural areas in the state. Landowners are contacted and if they wish to participate, a nonregulatory agreement is created with The Nature Conservancy. The Conservancy provides training and management information to the owners of these areas so they can learn effective stewardship techniques and activities. More information about The Nature Conservancy and its stewardship programs can be found at nature.org (TNC, 2001).

- (2) *Nonexclusive management.* There are several options for landowners that would like to retain ownership of the parcel but relinquish stewardship and conservation management to another organization. These options, discussed below, include establishing conservation easements, leases, deed restrictions, covenants, or TDRs.
 - (a) *Conservation easements.* A conservation easement is a legal agreement that transfers specific rights concerning the use of land by sale or donation to a government agency (municipal, county, or state), a qualified nonprofit organization (e.g., land trust or conservancy), or other legal entity without transferring title of the land (Cwikiel, 1996). This transfer of rights is registered with appropriate local officials, such as the registrar of deeds. The agreement is permanent, legally enforceable, and not subject to alteration unless permission is received in writing by the easement holder and all other cosigners (Arendt, 1997).

A conservation easement is a flexible tool that can be customized to set different levels of restrictions among different types of conservation areas in a parcel. In addition to

protecting and maintaining environmental benefits in perpetuity, landowners who donate conservation easements to a government agency or nonprofit group typically realize substantial income, property, and estate tax benefits resulting from the charitable donations. Their property value might be lowered, however, because the development rights were removed. Consequently, tax and estate planning professionals need to be consulted when a conservation easement is being contemplated.

- (b) *Leases.* Even though government agencies, land trusts, and other nonprofit organizations would prefer that conservation lands be acquired by donation or that conservation easements be placed on the property, some lands hold so much value as conservation areas that leasing is worth the expense and effort. Leasing a property allows the agency, trust, or organization to actively manage the land for conservation.
- (c) *Deed restrictions.* Deed restrictions are included in deeds for the purpose of constraining use of the land. In theory, deed restrictions are designed to perform functions similar to those of conservation easements. In practice, however, deed restrictions have proven to be much weaker substitutes because unlike conservation easements, deed restrictions do not necessarily designate or convey oversight responsibilities to a particular agency or organization to enforce protection and maintenance provisions. Also, deed restrictions can be relatively easy to modify or vacate through litigation. Modifying or nullifying an easement is difficult, especially if tax benefits have already been realized. For these reasons, conservation easements are generally preferred over deed restrictions.
- (d) *Covenants.* A covenant is similar to a deed restriction in that it restricts activities on a property, but it is in the form of a contract between the landowner and another party. The term *mutual covenants* is used to describe a situation where one or more nearby or adjacent landowners are contracted and covered by the same restrictions.
- (e) *Transfer of Development Rights.* The concept of TDRs as a watershed protection tool is based on the premise that ownership of land includes a “bundle” of property rights. One of these rights is the right to develop the property to its “highest and best use.” Although this right can be restricted by zoning building codes, environmental constraints, and other types of restrictions, the basic right to develop remains. A TDR system creates an opportunity for property owners to transfer development potential or density at one property, called a sending area to another property, called a receiving area. In the context of watershed planning objectives, TDR programs can be an effective way to transfer development potential from sensitive subwatersheds to subwatersheds that can better deal with increased imperviousness. In contrast to the conventional down-zoning approach, which withholds from landowners the value associated with the right to develop, TDR systems allow an opportunity for a landowner to be compensated for that value.

Most TDR systems require a legal restriction to ensure that future development will not occur on the “sending” site. Also, TDR programs can be fixed so that there are only a certain number of sending and receiving sites in an area or they can be flexible so that a sender and receiver can be matched as the situation allows. The following are general steps for setting up a TDR program (Redman/Johnston Associates, 1997):

- *Provide education and outreach.* The public should be familiar with the overall objectives of the program. Landowners and developers also need to be educated on how they will be affected.
- *Conduct an analysis of market conditions.* A successful program requires a market for TDR transfers.
- *Identify and designate TDR “receiving areas.”* Receiving areas should be capable of supporting growth. Factors include adequate land area, infrastructure, public services, and consideration of environmental constraints.
- *Identify and designate TDR “sending areas.”* Sending areas should support preservation and protection goals. Specific areas should be delineated to the parcel level.
- *Determine the nature of program.* Programs can be voluntary or mandatory. If mandatory, sending areas should be downzoned to control growth.
- *Determine development potential and allocate TDRs.* Compute current allowable densities in both receiving and sending areas, and then allocate TDRs from sending areas based on desired densities. For example, downzoning from a yield of 1 lot per 5 acres to 1 lot per 25 acres equates to 4 TDRs.
- *Consider a TDR Bank.* A TDR bank buys, holds, and sells TDRs. The bank can be either a government organization or a quasi-governmental entity.
- *Provide adequate resources.* A TDR program does not run itself. It needs staff and resources to administer and manage the program.

Case Study: Transfer of Development Credits Pilot Program, King County, Washington

King County, Washington’s Transfer of Development Credits (TDC) Pilot Program is a voluntary initiative that allows residential densities to be transferred from rural areas to urban areas better suited to absorb additional density (King County Office of Regional Policy and Planning, 2001). The following provisions were made:

- A \$1.5 million TDC bank was established to purchase and sell density credits.
- \$500,000 was appropriated for urban amenities to improve neighborhoods that will receive increased density.
- An extensive outreach effort has been launched to inform stakeholders about the program and identify potential receiving sites.
- The Rural Forest Commission has reviewed and approved sending site criteria to be used by the TDC bank.

The first successful TDC was finalized in 2000 (Simms, 2000a). Forest land totaling 313 acres was protected from development. The density credits were transferred to a developer to add 500,000 square feet of commercial space in the nearby city of Issaquah.

b. Relinquish ownership of the property

- (1) *Sale*. A property owner can choose to sell a property to a government agency or conservation organization. There are several options for selling, including selling the property for *full market value*, which allows the property owner to receive a price comparable to what would be received from a developer. The property can also be sold at a *bargain price*, which conveys the property to an agency or nonprofit organization at a price below market value. Thus, for tax purposes the transaction is considered part donation and part sale.

Landowners who want their land conserved but do not wish to sell it right away can make arrangements to give a *right of first refusal* to a specific agency or organization. Under this agreement, when the owner decides to sell his or her land, the designated agency or organization can exercise the right to match any offer received by the owner and obtain the property. Some communities have formalized this concept through an official map of land areas desired for conservation purposes (National Lands Trust, 1997). Owners are notified that their lands are on the map and earmarked for possible future public acquisition. When such owners decide to build, subdivide, or otherwise develop the land, the municipality is legally obligated to purchase the land at fair market value in a specific period of time. If the municipality fails to initiate the purchase or begin condemnation proceedings to acquire the land, the conservation designation on the official map is declared null and void and the owner can proceed with his or her plans for developing the property, subject to zoning and other regulations.

- (2) *Donation*. The donation of conservation land to a government agency, land trust, or other qualified nonprofit organization is another option for landowners. As with conservation easements, an owner can realize substantial tax benefits; the difference is that with donation the owner gives up title to the land. There are several donation scenarios other than *outright donation* that can be attractive to landowners that desire to continue to occupy, use, or otherwise realize some gain beyond tax benefits for their donation. These scenarios include the following:

- *Donation with reserved life estate*. This approach allows the owner to donate his or her property to an agency or nonprofit organization while retaining the right to occupy and use the property during his or her lifetime. Full title and control of the property is conveyed only after the death of the donor.
- *Donation by will*. This approach conveys the property to a government agency or conservation organization upon the death of the owner.
- *Charitable gift annuity*. This option allows an eligible charity, such as a land trust, to make regular annuity payments to one or two specific beneficiaries in exchange for the property.
- *Charitable remainder unitrust*. This scenario involves executing a conservation easement on the property and then putting the land into a trust. The trustee sells the land and invests the net proceeds of the sale. These monies provide for an annuity payment to one or two specific beneficiaries.

3. Establish and Protect Stream Buffers

Stream buffers should be protected and preserved as a conservation area because these areas provide many important functions and benefits, including

- Providing a “right-of-way” for lateral movement.
- Conveying floodwaters.
- Protecting streambanks from erosion.
- Treating runoff and reducing drainage problems from adjacent areas.
- Providing nesting areas and other wildlife habitat functions.
- Mitigating stream warming.
- Protecting wetlands.
- Providing recreational opportunities and aesthetic benefits.
- Increasing adjacent property values.

Factors to consider when designing new buffer systems include the quantity and velocity of runoff entering the buffer, the slope of the riparian area, soil types and infiltration capacity, and the density of development adjacent to the riparian corridor. It is important that sheet flow, not concentrated flow, be directed to the buffer. High-velocity runoff from steeply sloped or highly impervious areas can be problematic and promote excessive erosion and decreased pollutant removal. A flat, grassy area or a level spreader can be installed at the upland part of the buffer to slow the velocity of runoff and promote sheet flow. It is also important to consider that the pollutant removal capacity of a buffer is finite and can be exceeded in areas with high concentrations of pollutants in runoff.

Buffer width is an important measure of pollutant removal effectiveness. Buffers typically range from 20 to 200 feet and should include the 100-year floodplain, adjacent wetlands, steep slopes, or critical habitat areas (Schueler, 1995). A buffer at least 100 feet wide is recommended for water quality protection, and a 300-foot buffer is recommended to maintain a wildlife habitat

Case Study: Controlling Runoff from Nonpoint Sources in Wisconsin

Wisconsin is considering new regulations that would require more stringent, mandatory nonpoint source controls for both urban and agricultural sources (Barrett, 2001; Sandin, 2001a, 2001b). Although voluntary nonpoint source control programs have been in place for 20 years, participation was too low to improve water quality. Under the revised proposal, farmers would have to meet standards for applying fertilizer, controlling soil erosion from cropland, and managing manure. Buffers at least 20 feet wide would be required along all lakes and rivers bordered by cropland, barnyards, or feedlots whenever state dollars are available to pay 70 percent of the buffer costs. Similar buffers or retention areas would be required to control runoff to nearby streams from new or expanded state, county, or municipal roads. Additionally, bridges rebuilt over sensitive waters would need to be designed to channel runoff into detention ponds or chambers. Finally, owners and operators of golf courses, parks, and corporate lawns greater than 5 acres would be required to reduce fertilizer and pesticide applications.

Critics contend that financing constraints could limit implementation and burden local governments unless state grants were made available. Others question whether loopholes in the rules would exempt construction sites from installing vegetated buffers to capture runoff. If implemented successfully, however, the regulations would put Wisconsin ahead of other states on meeting standards and might provide an economic advantage in the future when other states might be struggling to meet those standards. The draft rules can be viewed at www.dnr.state.wi.us/org/water/wm/nps/admrules.html.

corridor. Wider buffers offer increased detention times, infiltration rates, and diversity of soil, vegetation, and wildlife.

According to Herson-Jones et al. (1995), forested buffers achieve 50 percent TSS removal; 23 to 96 percent phosphorus removal depending on the extent of TSS removal; greater than 40 percent lead removal; more than 60 percent copper, zinc, aluminum, and iron removal; and more than 70 percent oil and grease removal. Overall, aquatic buffers are highly effective at removing particulate pollutants, but less effective in removing soluble pollutants (such as nitrogen, for which documented removal rates range from -15 to 99 percent). Proper siting and design and regular maintenance enhance removal efficiency.

a. Establish a buffer ordinance

Buffer ordinances provide guidelines for buffer creation and maintenance. They should include the following provisions:

- Buffer boundaries to be clearly marked on local planning maps.
- Maintenance language that restricts vegetation and soil disturbance.
- Tables that illustrate buffer width adjustment by percent slope and type of stream.
- Direction on allowable uses and public education.

A model ordinance and examples of buffer ordinances from across the country can be found at www.epa.gov/owow/nps/ordinance. Buffer ordinances and other water-resource-related ordinances are described further in Management Measure 1.

Case Study: Stream Buffer Ordinances in Apex and Cary, North Carolina

Town commissioners in Apex and Cary, North Carolina, have agreed to set wider buffers between development and streams (Price, 2000). Under the new ordinance, buffers must be at least 50 feet wide along intermittent streams and must average 100 feet wide along perennial streams. The towns chose to use an average rather than a strict 100-foot minimum to allow landowners flexibility. In addition to the buffer ordinance, Apex and Cary also halved the limit of impervious surfaces on a given tract of land over which retention ponds are required to control runoff (from 24 percent to 12 percent). Town officials will hold a public hearing in to vote on the new regulations.

b. Develop vegetative and use strategies within management zones

Buffers can be divided into three zones—the streamside, middle, and upland zones (Herson-Jones et al., 1995). Dense vegetation in the streamside zone (recommended to be approximately 25 feet wide) prevents excessive activity in this sensitive area, maintains the physical integrity of the stream, and provides shade, litter, debris, and erosion protection. The width of a grassed or mostly forested middle zone (minimum of 50 feet) depends on the size of the stream and its floodplain and the location of protected areas such as wetlands or steep slopes. The upland zone, typically 25 feet wide, is an additional setback from the buffer and usually consists of lawn or turf. Zones in the buffer should be delineated to determine the types of vegetation that should be maintained or established.

Allowable land uses in the three zones vary. The streamside zone is limited to footpaths, runoff channels, and utility or roadway crossings. The middle zone may be used for recreation and runoff control practices. The upland zone may be used for many purposes, with the exception of septic system covers, permanent structures, or impervious covers. A depression incorporated into the design of the upland zone can detain runoff during storm events. This runoff is released slowly to the middle zone as sheet flow, which is then transferred to the dense streamside zone, designed to have zero discharge of surface water to the stream.

c. Establish provisions for buffer crossings

Stream crossings should minimize impacts on buffer integrity while providing crossing points for linear forms of development such as roads, bridges, golf course fairways, underground utilities, enclosed storm drains, and outfall channels (Schueler, 1995). They should also be designed to provide fish passage and to withstand overbank flows from the 100-year storm event. Design considerations for buffer crossings include minimizing the width of the crossing, orienting the crossing at a right angle to the stream, limiting the total number of crossings, ensuring that outfalls discharge at the invert elevation of the stream channel, and burying utility crossings at least 3 feet below the channel's invert elevation.

d. Integrate structural runoff management practices where appropriate

Depressions can be incorporated into the upland part of a stream buffer to provide runoff detention during storm events and to promote sheet flow over the middle zone of the buffer. A flat, grassed area or level spreader can also be used in the upland part of the buffer to create sheet flow and to promote infiltration over the rest of the buffer.

Storm water ponds and wetlands can be located inside or outside the buffer. According to Schueler (1995), ponds inside the buffer should be used only for runoff quantity control. Although ponds in the buffer treat the greatest possible drainage area, are more likely to maintain their water level during dry periods, provide a diversity of aquatic habitats, and can increase the total width of the buffer, they displace vegetation and might cause barriers to fish migration, modification of existing wetlands, and stream warming.

e. Develop buffer education and awareness programs

Buffer education efforts should foster community awareness and encourage stewardship. These objectives can be met by posting signs along the buffer boundaries that describe allowable activities in different parts of the buffer. Buffer owners can be educated by distributing pamphlets, hosting streamwalks, and holding meetings. New owners should be made aware of buffer limits and allowable uses when the property is transferred. Buffer stewardship can be encouraged through reforestation and “buffer-scaping” programs. Annual inspections can be done with “bufferwalks” to determine the extent of encroachment, devegetation, erosion, or excessive sediment deposition.

4. Promote Urban Forestry

Urban forestry is an effective tool for protecting watersheds because it can provide some of the storm water management required in urban areas. Trees decrease runoff by intercepting rain and promoting infiltration. This reduces the peak runoff flow and the total runoff volume that communities must manage, which can be financially beneficial to communities that have to build and maintain sewer and drainage systems (ENN, 2001). Also, trees provide shade, which lowers the temperature of urban heat islands and runoff.

Several organizations dedicated to promoting urban forestry can provide information and other resources to interested groups or individuals. For example, American Forests (www.americanforests.org) is a conservation organization that is working to improve the environment with trees and forests. The organization's Urban Forest Center offers tools to measure the environmental benefits of trees, such as pollution reduction and storm water management. These tools include the Regional Ecosystem Analysis (REA) and CITYgreen software packages. REA uses a combination of satellite data, field surveys, CITYgreen software, and other GIS technology to measure a region's or city's tree canopy and calculate its dollar value. CITYgreen allows users to compare the economic benefits of various planning scenarios by testing landscape ordinances, evaluating site plans, and modeling development scenarios that capture the benefits of trees. Information about the software is available at <http://www.nrcs.usda.gov/technical/land/pubs/97highlights.html>.

TreePeople is another forestry organization. It works with the U.S. Forest Service and has enlisted the help of thousands of students and volunteers to plant seedlings in the mountains around Southern California. Its mission is to inspire people to take responsibility for improving their immediate environment. Information about TreePeople is available at www.cyberjava.com/earth/tree/tree1.htm.

Case Study: Houston's Urban Forests

American Forests conducted a study of a 3.2 million-acre area in Houston to document urban forest cover (ENN, 2001). They also analyzed 25 individual sites with aerial photography using CITYgreen to map and measure tree cover and to calculate the benefits of Houston's trees. Study results show that trees provide significant benefits in storm water runoff reduction, energy savings, and pollutant removal. The study found that Houston's tree cover reduces the need for storm water management by 2.4 billion cubic feet per peak storm event, saving \$1.33 billion in one-time construction costs. As a result, American Forests made the following recommendations to the city of Houston:

- Improve green infrastructure by using tree cover data in land-use planning; growth management; and all transportation, public works, and development decision-making.
- Encourage the use of increased tree cover to meet storm water needs.
- Work to increase tree cover in the metropolitan area.

5. Encourage Waterbody and Natural Drainage Protection When Siting Developments

To meet the third element of this management measure, communities should implement management practices that guide future development and land use activities. This can be accomplished through zoning for natural resource protection. Several zoning techniques are described below. More details about these techniques and case studies can be found in *Protecting Wetlands: Tools for Local Governments in the Chesapeake Bay Region* (Chesapeake Bay Program, 1997).

Case Study: Creating a Uniform Storm Water Pollution Policy in Missouri

Officials in Columbia, Missouri, are interested in developing a uniform policy to deal with storm water pollution (Tritto, 2000). This effort was initiated in response to a recent back-and-forth battle between a developer and the Columbia City Council. Officials are reviewing a report developed by Missouri University researchers that evaluated the environmental sensitivity of 13 watersheds in the Columbia area using 12 criteria focused on human health and environmental protection. The report recommends limits on the percentage of impervious surfaces for developments based on categories of watershed sensitivity. Developers would be allowed to exceed these limits only by taking additional steps to control storm water pollution through the use of management practices. The approach recommended in the report would provide a financial incentive for developers to direct high-density developments to less sensitive watersheds because tougher standards on impervious areas and the costs of storm water controls would make it more expensive to develop in environmentally sensitive watersheds. City officials are also reviewing storm water management policies in other cities to develop uniform guidelines so that developers are better informed of what is expected of them.

a. Use cluster zoning and planned unit development

Cluster zoning, also known as open space zoning, requires developers to set aside larger areas of open space to protect sensitive site features such as wetlands or steep slopes and to concentrate development on a smaller portion of the site. Planned unit development is a type of zoning that encourages the use of cluster development but does not require it. For example, a set number of units could be spread across the site under typical residential zoning, but under cluster zoning, the same number of units could be concentrated on smaller lots on only a portion of the site, preserving the other portion for common open space to protect sensitive features or for use as a recreation area. Advantages of cluster development include

- Reducing the costs of infrastructure.
- Preserving sensitive areas.
- Increasing property values with proximity to open space.
- Preserving ecological, aesthetic, and recreational values.

b. Consider resource protection zones

Resource protection zones prohibit or limit the development or use of lands where the use has the potential to contribute to resource degradation. For example, authorized uses in an area adjacent to a waterbody could include hunting and fishing, conservation activities, or other low-intensity practices. Construction of permanent structures or siting of waste disposal areas would be

prohibited. Intermediate uses are typically approved on a case-by-case basis under a conditional use permit. Riparian buffer zones are an example of this type of zoning. It is important that the relationship between the quality of the resource and the protection zone, as well as the importance to the community of the resource itself, be well defined for resource protection zones to be accepted by the public, especially when the uses of private property are restricted.

c. Practice performance-based zoning

In performance-based zoning, developers are allowed flexibility in planning and designing the development as long as they meet minimum requirements set by the local government. These minimum requirements vary based on the particular resource protection objectives of the community but might include limiting the amount of impervious surfaces or preserving sensitive features such as wetlands or steep slopes with a high erosion potential. Developers can choose lot sizes, building types, site layouts, and other development characteristics as long as they meet the minimum criteria. Performance-based zoning offers natural resource protection for the community and increased flexibility for the developer. It requires greater effort on the part of the local government, however, to carefully tailor the language of the ordinance to ensure that resources are adequately protected and to carefully review development proposals to ensure that performance criteria are met.

d. Establish overlay zones

Overlay zones superimpose additional restrictions over existing zoning categories to provide extra protection for a particular natural resource. For example, if a wetland or endangered species habitat crosses the boundaries of several development zones, an overlay zone can be established to limit development in areas that affect the wetland. Overlay zones can also be used to limit development in areas with highly permeable soils to protect an underground drinking water source from contamination. The overlay zones would maintain the general land use category, such as residential or commercial, but would require additional protection, such as greater limits on impervious area or special vegetation protection requirements.

e. Establish bonus or incentive zoning

Bonus or incentive zoning is another method to allow developers greater flexibility in return for preservation of open space and sensitive or environmentally significant features. With incentive zoning, a developer might be allowed to develop at a higher density than normally allowed if the developer in return preserves additional open space, creates a wetland, or reduces the site's overall impervious area with underground parking, transportation modifications, or innovative site layouts. The success of bonus or incentive zoning is highly dependent on an individual developer's perception of the economic benefits of receiving additional density credits and cannot be relied on to protect natural resources. However, bonus or incentive zoning can successfully encourage voluntary and economically beneficial protection for open space and sensitive features.

f. Consider large lot zoning

Large lot zoning establishes a very low density of development; individual dwellings are built on lots of 5 acres or more. The purpose of large lot zoning is to spread development thinly, thereby conserving a large proportion of open space on each lot and reducing impacts on water resources. This method can produce undesirable results, however, including

- Promoting sprawl.
- Fragmenting habitats with more extensive infrastructure and lawns.
- Increasing reliance on automobile transportation.
- Excluding lower-income residents who cannot afford to purchase large parcels of land.

Although used in many areas, large lot zoning is not considered to be any more protective than other zoning tools.

g. Practice agricultural protection zoning

Many communities consider forestry and agriculture to be an integral part of rural heritage and strive to preserve these industries and the open space associated with them. According to the 1997 National Resources Inventory, nearly 16 million acres of forest, cropland, and open space were converted to urban and other uses from 1992 to 1997. The average rate for those 5 years—3.2 million acres per year—is more than twice the conversion rate of 1.4 million acres per year recorded from 1982 to 1992 (USDA-NRCS, 2000).

Agricultural lands can be protected by implementing a modified large-lot zoning ordinance that makes residential development less economically attractive. Alternatively, a cluster development ordinance can be established that specifies a density for an agricultural development and also requires that dwellings be built on small lots, leaving the remaining part of the site as agricultural open space. The ordinance can also specify that development must occur on the least productive part of the lot so the richest soils can be reserved for cultivation.

h. Use watershed-based zoning

Historically, zoning has been used to establish limits on building density and to separate uses believed to be inherently incompatible (Arendt, 1997). Watershed-based zoning, in contrast, uses watershed and subwatershed boundaries as the basis for making land use decisions. Typically, zoning objectives focus on maintaining or reducing impervious cover in sensitive subwatersheds and redirecting development to subwatersheds that are better able to absorb their influence (Caraco et al., 1998).

Case Study: King County, Washington, Growth Management Initiatives

Agricultural zoning ordinances can be combined with other initiatives to promote farming and forestry and to protect rural areas from being overtaken by urban sprawl (Sims, 2000b). The King County, Washington, Executive has undertaken several initiatives to promote diversity in lifestyle choices, encourage the continuation of farming and forestry, protect environmental quality and wildlife habitat, and maintain a link to the county's heritage by preserving rural areas. So far the county has reduced its development rate in rural areas from 15 percent in 1980 to 6 percent at present. The target is to further reduce the development rate to 4 percent. The county issued orders to close loopholes in subdivision and land segregation regulations and tightened subdivision requirements for rural lands. These efforts will ensure that new development is consistent with current environmental and development standards.

King County strives to promote agriculture and protect farmlands. Some of the county's initiatives include maintaining an agricultural district as an "unincorporated urban area" to permanently protect this area from development pressures, establishing the Puget Sound Fresh program to promote locally grown and produced products, establishing a Farm Link program to connect farmers with land to sell or lease with those wishing to farm, and providing improved services for rural community centers. The county also established a Rural Forest Commission to encourage forestry and maintain the forest land base in the county's rural areas. The county implemented a Farmlands Preservation Program, which has preserved 12,793 acres of agricultural lands through purchase or donation of development rights. Additionally, the county is able to preserve hundreds more acres of rural land each year through incentive-based taxation programs. Finally, King County's 2000 Comprehensive Plan includes the following goals and initiatives:

- Ensure that zoning complies with goals to reduce the rate of growth and protect the environment.
- Ensure that the types and scale of development in the rural area blend with traditional rural development.
- Implement recommendations from the forest commission to bolster King County's forest and farming economies.
- Consider alternative uses of agricultural land, such as for wetland mitigation or recreation, such that these uses will not harm the integrity of agriculture in the county.

More information about King County's Growth Management Initiatives can be found on the SmartGrowth Rural Legacy web page at www.metrokc.gov/smartgrowth/rural.htm.

i. Delineate urban growth boundaries

Urban growth boundaries are used to define urban and suburban development. The goal of these boundaries is to protect from development lands currently used for agriculture, forestry, and open space. The boundaries encourage more compact (i.e., infill) development, control urban sprawl, and help protect rural heritage. The approval process for new development can be streamlined within the growth boundary to further encourage development in these areas.

The duration or life span of growth boundaries is normally related to planning periods or cycles, typically 10 to 20 years. Boundaries should be examined at regular planning intervals, however, to assess whether conditions have changed since they were established.

Establishing the location of urban growth boundaries sometimes requires complex decision-making. Officials should be reasonably sure that there is sufficient land within the boundary to meet projected growth over the planning period and that public facilities and services can be provided at reasonable cost in a timely fashion. The potential impact of growth within the boundary on existing natural resources also needs to be determined. In the context of watershed planning, it is advantageous to use watershed boundaries or other natural features as urban growth boundaries. In this manner, key or sensitive watersheds can be protected from the impacts of development.

Case Study: Balancing Development with Preservation in Southern California

As one of the nation's fastest growing regions, southern California is seeking to balance development with preservation (Verden, 2000). Local, state, and federal officials recently approved the Riverside County Plan, which involved multiagency cooperation in identifying where development may occur and where land should be preserved. Over the next 50 years, the Riverside County Plan will serve as a blueprint for building new roads, shopping centers, and homes, while also preserving rapidly disappearing habitat. The plan is designed to avoid costly delays and confrontations between regulators and developers. With the population of Riverside County expected to double in 20 years, the plan will help developers accommodate growth while it also protects rare plants and animals. State and federal land, transportation, and wildlife managers hope the Riverside County Plan will be a model for other communities struggling to balance development and preservation.

Case Study: Urban Growth Boundaries in Oregon

Oregon uses urban growth boundaries to protect rural lands from urban sprawl. The area between the urban growth boundary and the city limits is urbanizable land or land that will accommodate a city's future growth over a 20-year period. Zoning prohibits urban development on land outside the urban growth boundary. Most of this land will continue to be used for forestry, farming, or low-density residential development (University of Oregon, 1995).

Determining urban growth boundaries is a cooperative process between the cities, counties, districts, and citizens affected by the boundary. The amount of land included in the boundary depends on future growth expectations (how much vacant land is needed to accommodate expected growth). Once land needs are determined, the amount of vacant land available within the current city limits is subtracted from the amount of land necessary for growth. The remainder is the amount of land outside the city limits that is needed to accommodate future growth. The city must then determine which areas to include within the boundary based on three main factors: efficient use of land, protection of agricultural land at the city's edge, and cost-effective public services. In some cases, urban growth boundaries can be modified. To modify a boundary, a proposal must be submitted and the community must determine the best location at which to change the boundary (University of Oregon, 1995).

Urban growth boundaries in the Portland metropolitan area include approximately 369 square miles and include 24 cities, including the urban portions of Washington, Multnomah, and Clackamas counties and a reported 1.3 million people. Portland's urban growth boundary has been the subject of much controversy. In the past 20 years, the boundary has been moved more than 30 times. Supporters of Portland's urban growth boundary argue that it has helped to control urban sprawl, while opponents argue that it has caused land and housing price inflation. Both topics have been researched in great detail and remain controversial (Multnomah County, 2001).

More information about Oregon's urban growth boundaries is available at www.multnomah.lib.or.us/metro/growth/ugbursa/ugbursa.html and darkwing.uoregon.edu/~pppm/landuse/UGB.html.

Case Study: Curbing Growth in the Phoenix Area

Political leaders in Arizona are striving to manage development in light of mushrooming growth, especially in the Phoenix area (Morrison, 2000). Governor Jane Dee Hull called a special session of the legislature in February 2000 to address the pressing issue of development with a package of growth-management bills. One part of these bills will give county governments the ability to make development agreements and to charge developers fees for services. Another part of the bills placed an initiative on the ballot that would protect from development up to 3 percent of state trust land. The Sierra Club plans to propose another ballot measure that requires cities of more the 2,500 people to draw development boundaries only large enough to accommodate a decade of population growth.

Information Resources

The Center for Watershed Protection's *Rapid Watershed Planning Handbook*, published in 1998, describes techniques communities can use to more effectively protect and restore water resources. This document is available for purchase from the Center for Watershed Protection's web site (www.cwp.org).

The Chesapeake Bay Program's (1997) *Protecting Wetlands: Tools for Local Governments in the Chesapeake Bay Region* is available from the Chesapeake Bay Program's web site at www.chesapeakebay.net.

The Conservation Fund's web site, located at www.conservationfund.org, provides information on land acquisition, community initiatives, leadership training, and sustainable conservation solutions emphasizing the integration of economic and environmental goals.

Correll's (2000) web site, entitled *Vegetated Stream Riparian Zones: Their Effects on Stream Nutrients, Sediments, and Toxic Substances*, presents an annotated and indexed bibliography of buffer strip literature. See www.riparian.net/correll.htm.

The Delaware Department of Natural Resources and Environmental Control, Division of Soil and Water Conservation, has produced the document *Delaware's Riparian Buffers* (no date).

Eco-Compass (Island Press, 2000) is an information resource for urban sprawl issues. Developed by Island Press, Eco-Compass is an Internet guide to a wide range of environmental information, including ecosystems, communities, global change, and economics. The urban sprawl feature of Eco-Compass provides a summary of the major issues relating to sprawl as well as an examination of the lessons that can be learned from Atlanta, a city that has experienced tremendous growth in the past decade. The site also includes links to more than 50 of the best sprawl-related web sites and publications. More information about Eco-Compass is available at www.islandpress.org/ecocompass/community/sprawl.html.

The Natural Lands Trust's 1997 publication *Growing Greener: Putting Conservation into Local Codes* is available from Natural Land Trust, 1031 Palmers Mill Road, Media, PA 19063; telephone 610-353-5587; e-mail planning@natlands.org. Other information and resources pertaining to land preservation and land use planning can be found at the Natural Lands Trust's web site at www.natlands.org.

Schueler's (1995) manual, *Site Planning for Urban Stream Protection*, is available for purchase from the Metropolitan Washington Council of Governments' web site at www.mwcog.org/ic/95708.html.

The Smart Growth Network is a nationwide effort coordinated by EPA's Urban and Economic Development Division (International City/County Management Association, 2000). EPA is working through cooperative partnerships with a diverse network of organizations to encourage development that better serves the economic, environmental, and social needs of communities. The Network provides a forum for information-sharing, education, tool development and application, and collaboration on smart growth issues. Smart growth approaches focus on

flexible zoning, preventive planning, intelligent management of natural resources and water quality, and implementation of treatment and control technologies at multiple scales from development sites to watershed planning. For more information about the Smart Growth Network, visit www.smartgrowth.org or contact ICMA—Smart Growth Network, 777 North Capitol St., NE, Suite 500, Washington, DC 20002-4201; telephone 202-962-3591; e-mail nsimon@icma.org.

The Mid-America Regional Council (MARC) initiated a project to raise awareness of the relationship between land development and transportation systems. In *Principles of Transit Supportive Development*, MARC (no date) presents alternative approaches to land development that encourage a more sustainable and balanced transportation system. The organization promotes community designs that enable citizens to walk, bike, ride transit, and drive from home to shops, schools, and services. For more information about the potential of transit supportive development, contact MARC at 816-474-4240 or visit their web site at www.marc.org/transportation.

The Local Government Commission (www.lgc.org) is a nonprofit organization that provides peer networking opportunities, acts as an interface between city and county officials, and provides practical policy ideas for addressing serious environmental and social problems. They provide guidelines and resources for communities to improve community design, transportation, economic development, environment, energy, and waste prevention. A list of publications can be found at www.lgc.org/bookstore/land_use/publications/index.html.

The Northeastern Illinois Planning Commission (1988) published *Model Stream and Wetland Protection Ordinance for the Creation of a Lowland Conservancy Overlay District: A Guide for Local Officials*, which can be ordered from their web site at www.nipc.cog.il.us/pubslst.htm.

The National Association of Conservation Districts web site (www.nacdnet.org) contains a list of conservation districts across the country as well as conservation resources for districts, educators, and the public.

In July 2001 the National Governors' Association Center for Best Practices published *New Community Design to the Rescue: Fulfilling Another American Dream* (Hirschhorn and Souza, 2001), which provides alternatives to sprawl through "new community design." The book includes a checklist for local governments to evaluate communities and development projects for consistency with smart growth principles and provides examples of infill, suburban redevelopment, and greenfields projects that have successfully incorporated new community design principles. Innovative policies and actions taken by states to encourage new community design are also included. This publication can be purchased at the National Governors' Association web site at www.nga.org or downloaded in PDF format at www.nga.org/cda/files/072001NCDFull.pdf.

The concept of creating and maintaining an interconnected network of protected land and water, called Green Infrastructure, is presented at www.greeninfrastructure.net. Green Infrastructure supports native species, maintains natural ecological processes, sustains air and water resources, and contributes to health and quality of life. This web site, developed by The Conservation Fund with support from USDA Cooperative Forestry, contains information to aid in implementing a

comprehensive conservation program and includes resources such as searchable profiles, training information, events, and references databases.

EPA's Green Communities Program encourages successful community-based environmental protection and sustainable community development. The Green Community Assistance Kit provides technical assistance and training for planning green communities. Information about the Green Communities Program can be found at www.epa.gov/greenkit.

Other useful EPA publications:

U.S. Environmental Protection Agency (USEPA). 1996. *Green Development: Literature Summary and Benefits Associated with Alternative Development Approaches*. EPA841-B-97-001. U.S. Environmental Protection Agency, Washington, DC. Available through EPA's National Service Center for Environmental Publications (NSCEP) at www.epa.gov/ncepihom or by calling 800-490-9198.

U.S. Environmental Protection Agency (USEPA). 1998. *The Volunteer Monitor*. U.S. Environmental Protection Agency, Washington DC. Available in HTML format at www.epa.gov/volunteer/spring98/index.html.

U.S. Environmental Protection Agency (USEPA). 1999. *Model Ordinances to Protect Local Resources*. U.S. Environmental Protection Agency, Washington DC. Available in HTML format at www.epa.gov/owow/nps/ordinance.

U.S. Environmental Protection Agency (USEPA). 2001. *Monitoring Water Quality: Volunteer Monitoring*. U.S. Environmental Protection Agency, Washington DC. Available in HTML format at www.epa.gov/volunteer.

References

- Arendt, R.G. 1997. *Growing Greener: Putting Conservation into Local Codes*. Natural Lands Trust, Inc., Media, PA.
- Barrett, R. 2001, March 22. Runoff rules spark debate. *Milwaukee Journal Sentinel*. www.jsonline.com/news/wauk/mar01/runoff23032201a.asp. Last updated March 22, 2001. Accessed May 8, 2001.
- Caraco, D., R. Claytor, P. Hinkle, H.Y. Kwon, T. Schueler, C. Swann, S. Vysotsky, and J. Zielinski. 1998. *Rapid Watershed Planning Handbook*. Center for Watershed Protection, Ellicott City, MD.
- Chesapeake Bay Program. 1997. *Protecting Wetlands: Tools for Local Governments in the Chesapeake Bay Region*. Prepared for U.S. Environmental Protection Agency, Washington, DC, by the Chesapeake Bay Program, Annapolis, MD.
- Correll, D. 2000. *Vegetated Stream Riparian Zones: Their Effects on Stream Nutrients, Sediments, and Toxic Substances*. www.riparian.net/correll.htm. Last updated September 2001. Accessed May 28, 2002.
- Cwikiel, W. 1996. *Living With Michigan Wetlands: A Landowner's Guide*. Tip of the Mitt Watershed Council, Conway, MI.
- Environmental News Network (ENN). 2001, January 10. *Calculating the Benefits of Houston's Urban Trees*. www.enn.com/extras/primer-friendly.asp?storyid=3085&pr=1. Last updated January 10, 2001. Accessed April 6, 2001.
- Herson-Jones, L.M., M. Hearty, and B. Jordan. 1995. *Riparian Buffer Strategies for Urban Watersheds*. Metropolitan Washington Council of Governments, Washington, DC.
- Hirschhorn, J.S., and P. Souza. 2001. *New Community Design to the Rescue: Fulfilling Another American Dream*. National Governors' Association, Washington, DC.
- Holler, S. 1989. Buffer Strips in Watershed Management. In *Watershed Management Strategies for New Jersey*, Cook College Department of Environmental Resources and New Jersey Agricultural Experiment Station, Rutgers University, New Brunswick, NJ, pp. 69–116.
- International City/County Management Association. 2000. *Smart Growth Network*. www.smartgrowth.org. Last updated June 17, 2000. Accessed June 21, 2000.
- Island Press. 2000. *Eco-Compass: Sprawl Cities*. www.islandpress.org/ecocompass/community/sprawl.html. Accessed April 4, 2001.
- King County Office of Regional Policy and Planning. 2001. *Transfer of Development Credits (TDC) Program*. Last updated April 23, 2001. Accessed May 1, 2001.

- Land Trust Alliance. 2001. Links to Web Sites of Sponsor Members of the Land Trust Alliance. www.lta.org/resources/links. Last updated February 16, 2001. Accessed May 1, 2001
- Local Government Commission. No date. *Local Government Commission*. www.lgc.org. Accessed May 11, 2001.
- Mantel, M.A., S.F. Harper, and L. Propst. 1990. *Creating Successful Communities: A Guidebook to Growth Management Strategies*. Island Press, Washington, DC.
- Meeks, G. 1990. *State Land Conservation and Growth Management Policy: A Legislator's Guide*. National Conference of State Legislators, Washington, DC.
- Michigan Department of Environmental Quality. No date. *Into Every Life a Little Rain Must Fall*. Michigan Department of Environmental Quality, Madison, WI.
- Mid-America Regional Council (MARC). No date. *Principles of Transit Supportive Development*. Mid-America Regional Council, Kansas City, MO.
- Morrison, M. 2000, June 5. A sudden oasis, or just sprawl? Phoenix exurb sharpens growth debate. *The Washington Post*, p. A3.
- Multnomah County, Oregon. 2001. *Urban Growth Boundary*. Multnomah County, Oregon, Metro Regional Services. www.multnomah.lib.or.us/metro/growth/ugbursa/ugbursa.html. Last updated March 6, 2001. Accessed April 5, 2001.
- National Lands Trust. 1997. *Growing Greener: A Conservation Planning Workbook for Municipal Officials in Pennsylvania*. National Lands Trust, Media, PA.
- National Park Service (NPS). 2001. *Colonial National Historical Park*. www.nps.gov/colo/index.htm. Last updated May 2, 2001. Accessed May 2, 2001.
- Price, J. 2000, December 7. Apex leaders agree to beef up their stream-protection measures: New rules call for larger buffers. *The Raleigh News and Observer*.
- Redman/Johnson Associates. 1997. *Beyond Sprawl—Land Management Techniques for the Chesapeake Bay: A Handbook for Local Governments*. EPA 903-B-97-005. U.S. Environmental Protection Agency, Region 3, Chesapeake Bay Program Office, Annapolis, MD.
- Sandin, J. 2001a, January 23. Rules would control foul runoff. *Milwaukee Journal Sentinel*. www.jsonline.com/news/metro/jan01/runoff23012201a.asp. Last updated January 23, 2001. Accessed May 2, 2001.
- Sandin, J. 2001b, February 26. Hearings target water pollution. *Milwaukee Journal Sentinel*. www.jsonline.com/news/metro/feb01/pollute27022601a.asp. Last updated February 26, 2001. Accessed May 8, 2001.

- Schueler, T. 1995. *Site Planning for Urban Stream Protection*. Metropolitan Washington Council of Governments, Washington, DC.
- Sims, R. 2000a. *First Transfer of Development Credits in NW Celebrated*. www.metrokc.gov/exec/news/2000/032800.htm. Last updated March 28, 2000. Accessed May 4, 2001.
- Sims, R. 2000b. *SmartGrowth: Rural Legacy*. www.metrokc.gov/smartgrowth/rural.htm. Last updated May 31, 2000. Accessed May 1, 2001.
- Stapleton, B. 1999. Old B/A Gas Station Finds New Life. www.oldgas.com/info/banewtonville.html. Last updated September 11, 1999. Accessed February 21, 2000.
- The Nature Conservancy. 2000. The Nature Conservancy. nature.org. Accessed May 2, 2001.
- Tritto, C. 2000, November 13. City seeks policy on storm water. *Missourian*, p. 9.
- University of Oregon. 1995. *What is an Urban Growth Boundary?* darkwing.uoregon.edu/~pppm/landuse/UGB.html. Last updated May 10, 1995. Accessed April 5, 2001.
- U.S. Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS). 2000. *1997 National Resources Inventory*. rad2.nhq.nrcs.usda.gov/CCS/devtable.html. Accessed June 5, 2000. <http://www.nrcs.usda.gov/technical/land/pubs/97highlights.html>. Accessed July 16, 2002.
- U.S. Environmental Protection Agency (USEPA). 1998. *The Volunteer Monitor*. www.epa.gov/volunteer/spring98/index.html. Last updated January 21, 1999. Accessed April 3, 2001.
- Verden, T. 2000, September 25. Officials sign pact to balance development with preservation. *The Sacramento Bee*, p. N10.